REMARKS/ARGUMENTS

Claims 1, 2, 4-6, 8, 10-17, 19 and 20 have been rejected under 35 U.S.C. §102(e) as being anticipated by United States Patent No. 6,466,649 to Walance. Additionally, claims 3, 9 and 18 have been rejected, under 35 U.S.C § 103(a) as being obvious over Walance in view of United States Patent No. 5,949,236 to Franchville.

The Examiner states that Walance teaches a method for estimating distances to irregularities on a subscriber loop comprising the steps of measuring a loop response as a function of frequency at a loop end, weighting the loop response with a pre-selected prolate spheroidal wave function to produce a weighted response and generating a spectral analysis of the weighted response wherein the estimated distances to the irregularities correspond to peaks in the spectral analysis. The Examiner cites column 1, lines 6-10, column 1, lines 60-67 and column 2, lines 5-31 as being the location in Walance that describes these claimed steps of independent claim 1. Applicant respectfully disagrees that Walance teaches the step of "weighting the loop response with a pre-selected prolate spheroidal wave function to produce a weighted response." At column 2, line 11, Walance states that the "response data is weighted to optimize the accuracy of the analysis." Walance does not, however, teach or suggest the use of a pre-selected prolate spheroidal wave function for such weighting. Applicant respectfully suggests that claims are neither taught nor suggested by Walance alone or in conjunction with Frenchville for this reason.

The advantageous characteristics of the <u>prolate spheroidal wave function</u> (pswf) recited by the Applicant have not been fully comprehended by the Examiner. The particular pswf disclosed and claimed by the Applicant is the only mathematical function that has essentially finite support in both its domain of definition and the transform of this domain. For example, as used in the specification, if the domain of definition is the frequency domain, then the transformed domain is taken as the time domain. For instance, it can be seen from FIG. 5A that the domain of definition of the pswf encompasses 1000 abscissa points. From FIG. 5B, it can be seen that support of the transform of the pswf depicted in FIG. 5A is limited to, on a normalized basis, values between 0 and approximately 0.14. <u>No other weight function, including rectangular, Hamming, Hanning, etc., has the desirable property of finite range of support in both domains.</u> Because of this property, it is now possible to preclude interactions between and among frequency components in a waveform that are spaced sufficiently far apart. For instance, if a waveform is composed of two sinusoids of frequency f_1 and f_2, and the waveform is weighted by the pswf, then in the transform domain, the frequencies f_1 and f_2 can be individually identified if

there is sufficient separation between the two frequencies. Moreover, it is guaranteed that there is no interaction between the two frequencies because of the pswf weighting; no other weighting window provides this guarantee.

FIGS. 8A and 8B depict this property of the pswf. FIG. 8A shows that rectangular weighting masks the peak at about 175 on the normalized scale; the same would basically be true for the Hanning, Hamming, etc. windows. On the other hand, FIG. 8B depicts that, because the interaction between the two frequency components is eliminated by pswf weighting, the two frequency components are clearly identifiable.

Accordingly, the Examiner's reasoning that both Walance and the Applicant use a similar approach for weighting of the response and, consequently, Walance "reads on the applicant limitation as claimed" is clearly erroneous. The Applicant is quite willing to acknowledge that it is well-known to weight a waveform of limited duration (say in the frequency domain as is the present case) so as to "avoid spurious results" in the transform domain as stated by Walance; however, that is all that Walance teaches or suggests. The Applicant strongly contends that the use of a prolate spheroidal wave function for weighing is neither taught nor suggested.

Characteristic Function Aspect of the Inventive Subject Matter

In addition, the characteristic function recited by the Applicant must be fully appreciated by the Examiner. The use of the characteristic function builds upon the principles elucidated in the foregoing paragraphs. Recall it is stated above that:

"..., if a waveform is composed of two sinusoids of frequency f_1 and f_2, and the waveform is weighted by the pswf, then in the transform domain, the frequencies f_1 and f_2 can be individually identified if there is sufficient separation between the two frequencies. Moreover, it is guaranteed that there is no interaction between the two frequencies because of the pswf weighting; no other weighting window provides this guarantee."

The purpose of the characteristic function is to actually induce sufficient separation between and among frequency components. Again with reference to Applicant's FIG. 8B and the discussion of this figure, it is seen that there are two peaks in the transform of the weighted response, namely, a peak at roughly 175 and another peak at roughly 280 on the normalized scale. The first peak is separated from the second peak by 105 normalized units, or in terms of percentages, the second peak is within 60% of the first peak. Now conjecture it is

possible to "slide" the peak at 175 to 10 on the normalized scale and, correspondingly, the peak at 280 slides to 115 on the normalized scale. Then the first peak is still separated from the second peak by 105 units, but in terms of percentage, the separation between the peaks increases to 1050%. If the first peak slides to 1 unit, the percentage separation becomes 10500%. In the limit, as the first peak slides towards 0 on the normalized scale, the percentage separation approaches infinity.

From the viewpoint of detecting each peak as it is shifted to 0, it is extremely simple to build a "low-pass" filter centered about 0 on the normalized scale in order to isolate the peak at 0 from "nearby" peaks; that is, whereas the location of peaks before shifting may be "close", after shifting, the peaks are sufficiently separated to effect easy detection. On the other hand, it is much more complicated to build a "band-pass" filter so as to distinguish the peak at 170 from the peak at 280. As the peaks approach one another, the "band-pass" filter becomes virtually impossible to design. Thus the key to processing the loop response is to slide each peak to 0 on the normalized scale to accurately identify the actual location of each peak on the normalized scale.

To see how dramatically the use of the characteristic function improves the resolution of peaks, reference is first made to Applicant's FIG. 10. Because of the loop structure, it is expected that there should be three primary peaks and possibly secondary peaks due to multiple reflections from the loop discontinuities. It is virtually impossible to discern any more than two peaks from FIG. 10. On the other hand with reference to FIG. 11, if the loop response is iteratively shifted and the multiplicity of peaks at 0 on the normalized scale are noted as the iteration process unfolds, then it is possible to discern the primary as well as secondary peaks.

To generate the characteristic function, consider the following summary of details disclosed in the Applicant's specification. First, note the following well-known relation: $\cos(A)\cos(B) = [\cos(A-B) + \cos(A+B)] / 2$ (equation 4 of the specification), where A and B are arbitrary. Whenever A=B, then this equation becomes $\cos(A)\cos(A) = [\ 1 + \cos(2A)] / 2$. Upon the transformation of this latter equation, there is a peak at the 0 abscissa value from the (1/2) term, and another peak at the abscissa corresponding to the term $[\cos(2A)] / 2$.

Next, apply this principle to the loop response by multiplying equation (3) of the specification by $\cos(2\beta_C L_C)$ where β_C is presumed known (e.g., β for 26-gauge cable, or 24-

gauge cable, or an average over the known cable gauges) and L_C is a selected length. This leads to, ignoring the multiple reflection terms for the moment:

$$[\sum_{i=1}^{N} A_i(\omega)exp(-2\alpha_i L_i)cos(2\beta_i L_i)]\,cos(2\beta_C L_C). \qquad (6)$$

If $\beta_C = \beta i$, and focusing on the cosine terms only of equation (6) as follows:

$$cos(2\beta_i L_i)cos(2\beta_C L_C) = [cos(2\beta_c(L_i - L_c)) + cos(2\beta_c(L_i + L_c))]/2. \qquad (7)$$

Equation (7) is the characteristic function for a given L_C.

If L_C is <u>iteratively</u> varied over a range (say over the length of the loop or more typically over an intermediate length encompassing the irregularities), then at values of L_C equal to the L_i's, the right-hand side of equation (7) becomes

$$[1 + cos(4\beta_C L_C)]/2. \qquad (8)$$

Thus, peaks in the spectral domain at each L_i can be shifted to the 0-abscissa value by the proper choice of L_C. <u>The term at the 0-abscissa is called the characteristic value</u>. If each characteristic value is determined for each of the iteratively selected values of L_C, and all the characteristic values form a set, then the peaks in this set of characteristic values estimate the L_i's.

From this process, it is clear that Walance is distinguishable. Walance merely teaches or suggests that the weighted line response is multiplied, <u>only once</u>, by a loss compensation function. The loss compensation function is introduced to enhance the <u>amplitude</u> of the line response since the amplitude of the line response is known to decay exponentially (see equation (6) above). The Applicant, on the other hand, totally ignores the amplitude of the loop response and focuses only on the zero-crossings or frequencies of the loop response. <u>Frequency shifting</u> is accomplished by introducing a <u>multiplicative factor</u>, namely, a cosine function. Moreover, this multiplicative factor is <u>iterated</u> over a frequency range that includes the anticipated peaks in the transformed, weighted loop response. (This aspect of the disclosure has been referred to as "distance filtering", meaning that it now becomes possible to focus on the subset of distances to discontinuities that cause the frequency peaks).

Hypothesized Loop Aspect of the Inventive Subject Matter

The Applicant's inventive subject matter relates to determining the composition of a loop. Accordingly, once the set of peaks in the characteristic values has been determined with sufficient accuracy by mitigating interactions, it now becomes necessary to devise a methodology to make effective use of the set of peaks. The Applicant has devised a procedure wherein a set of loops is hypothesized which give rise, presumably, to the same set of characteristic values. The hypothesized set is selected based upon set of peaks in the characteristic values, as exemplified in detail on pages 20 and 21 of the specification. For example, the loop of FIG. 11A exhibits five peaks in the set of characteristic values. It is easily deduced that the first two peaks are due to irregularities, whereas the last three peaks are either due irregularities or multiple reflections. The hypothesized loops mirror these considerations. Then a similarity measure is applied to determine the loop having the closest set of peaks in its characteristic values as compared to the set from the actual loop under test.

Walance speaks of "bins", and the Examiner misstates the Walance "determines the bins of responses on the bases of assumption or hypothesis". In fact, the determination of "bins" bears no relation to assumption or hypothesis, and certainly no relation to hypothesized loop structures. The "bins" are merely labels on the discrete points in the transformed domain. It is well-known that one can process a waveform by sampling said waveform to produce a sampled waveform. Then if a so-called Discrete Fourier Transform (DFT) algorithm is used to transform the sampled waveform (as in Walance), then in the transform domain, there are data points appearing at a finite set of points corresponding to the number of samples in the original waveform -- each of the points in the transformed domain is referred to as a "bin". The Examiner's rationale is untenable.

Comparison of Flow Diagrams between Applicant and Walance

As final evidence of the disparity between Walance and the Applicant's claimed subject matter, it is instructive to compare the process steps as taught or suggested by Walance's FIG. 3 to those steps as embodied and described with respect to Applicant's FIG. 13. With such a detailed analysis it becomes evident that the functionality of each overall process is entirely different.

The side-by-side comparison is meant to highlight the distinguishing differences between the Applicant's inventive subject matter and the prior art as exhibited by Walance, and is interpreted as follows: (1) those processes listed on the same row are commensurate functionally, but <u>each process is effected in a different way to achieve a different result</u>; and (2) some processing steps do not have counterparts, so they stand-alone in rows of the table. The totality in the differences between the column entries is immediately obvious. It is reasonable to expect that, to one of ordinary skill in the art, that since the problems to be solved are entirely different (<u>Walance</u>: location of a discontinuities (e.g., bridged tap); <u>Applicant</u>: loop composition), the totality of steps considered as a whole must necessarily be significantly different. *Such steps are what are disclosed and claimed by the Applicant.*

Applicants	Walance
	W1) apply swept sinusoid to the line
A1) measure a loop response as a function of frequency at a loop end (implicit that a swept sinusoid is applied to the loop	W2) measure and store line response
A2) weight the loop response with a ***prolate spheroidal wave function*** to produce a weighted response (***so as to mitigate interaction of peaks in the weighted response upon transformation*** – as per A4)	W3) weight response to remove discontinuities between start and end of data ***to avoid spurious results*** and thereby produce a weighted response
A3) ***iteratively*** multiply the weighted response with a pre-determined multiplier function (a cosinusoid) to produce a characteristic function (which shifts frequency components of the weighted response to zero frequency)	
A4) transform ***each iteratively produced characteristic function*** to determine a corresponding set of characteristic values	
A5) ***hypothesize a set of loops wherein each of the loops has a set of characteristic values commensurate with the set of characteristic values of the measured loop***	
A6) ***select one hypothesized loop by comparing each set of characteristic values to the set of characteristic values of the measured loop***	
	W4) apply, only once, a loss compensation function to the amplitude of the weighted response
	W5) transform the loss-compensated response
	W6) set thresholds to determine if peaks in the transformed response are indicative of discontinuities on the line
	W7) respectively place peaks in loss-compensated response into bins by comparing each peak to the thresholds set in step W6 wherein the selected peaks are indicative of the discontinuities on the line
Result	**Result**
Composition of the loop	Distance to discontinuities on the line; Line structure remains unknown

Applicant respectfully suggests that all independent claims, i.e., claims 1, 6, 13 and 15 are allowable and, therefore, all dependent claims depending therefrom are also allowable. Applicant hereby requests reconsideration of claims 1-6 and 8-20, in view of the amendments and the above discussion, and allowance thereof is respectfully requested.

Respectfully submitted,

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